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EDITORIAL

The lubricating system plays a part of considerable importance in turbine lubrication. The partial filtration system described in this issue in the article on "Turbine Oil Filtering Systems" is exceptionally well adapted to turbine lubrication. This article makes a fitting supplement to that published last month on "Lubrication of Steam Turbines."

The test on The Muncie Oil Engine, a report of which is given in this issue together with a description of The Muncie Oil Engine itself, is characteristic of the tests which are constantly being made by our engineers on internal combustion engines. These tests have demonstrated conclusively that Texaco Ursa Oil is eminently suitable for any type of Diesel or Semi-Diesel engine, not only for the internal lubrication of the power cylinders and air compressors but for external lubrication as well. Texaco Ursa Oil is now being recommended by a large number of manufacturers of Diesel and Semi-Diesel engines.

Two of the best articles of the year on the subject of lubrication were those by Lieut. G. S. Bryan of the U. S. Navy, printed in the Journal of the American Society of Naval Engineers. The first of these articles on "Motor Cylinder Lubrication" is a study of the conditions under which lubrication takes place and of the characteristics of motor cylinder oils that determine their suitability for these conditions. The second article entitled "Practical Lubrication" is a general discussion of the subject of lubricants and the conditions under which they operate. As the U. S. Navy uses Texaco lubricating oils for a very large percentage of its work, The Texas Company made reprints of these articles, and will be pleased to send copies to any of the readers of "Lubrication" who are interested. A card addressed to the editor will secure copies by return mail.

TURBINE OIL FILTERING SYSTEMS

By Edwin M. May
New York Manager, The Richardson-Phenix Co.

In the modern steam turbine power plant a great deal of attention is being paid to the purification of the lubricating oil. In fact in most plants it is considered just as vital to the satisfactory operation of the turbines as any other factor, because the operation of the turbine depends on perfect lubrication.

Practically all turbines have a self-contained oil circulating system, but this must not be confused with a real filtering system. In such a turbine, if a sample of oil is taken from the reservoir it will be found to contain suspended foreign matter, little particles of grit and dirt which cause friction and help heat up the bearings, and drops of water which keep the oil from maintaining a film, thus allowing the bearings and journals to come in contact. It is also quite possible that in the lower parts of the turbine casing and in the oil pipes, deposits of "muck," due to partial breaking down of the oil, may have accumulated, thus impairing the efficiency of the whole body of oil. All this trouble is due to lack of filtration and may be summarized as follows:

1—Besides other impurities, water frequently gets into the oil, due to leakage of steam past the packing glands.

2—As the oil circulates at a rapid rate, insufficient time is allowed for separation and precipitation within the small reservoir in the turbine.

3—The result is that the bearings receive a mixture of oil and water which does not possess the necessary lubricating properties.

4—On account of the high temperature, some of the best mineral oils form oxidation products which in time become insoluble in the oil and settle, forming a muck.

5—If this muck is not continuously removed, it clogs the oil piping and cooler and finally gets into the bearings.

In small turbines and particularly in that kind in which the oil is not brought to the bearings under pressure, continuous filtration of all of the oil circulated may be used, but on all medium and large size turbines, on account of the enormous quantities of oil circulated, recourse must be had either to the batch system of filtration, or to the newly evolved and highly successful partial system of filtration.

In most steam turbine plants the cost of a continuous filtration system would be prohibitive, as it would require a filtering plant larger than the turbine. The common method in use for filtering turbine oil is by means of a batch filter. With this type of filter, all of the oil is periodically removed from the turbine and conducted into the dirty oil compartment in the upper part of the filter, where it is heated and allowed to settle for a given length of time, the water and "muck" precipitating from the oil by gravity. The water and sludge is drawn off, and the oil is passed through filtering units into the clean oil compartment where it remains until it is pumped into the turbine again. The filtering compartment consists of a number of filtering units constructed as described below, and has a float valve in it to regulate the head of dirty oil over the filtering units, so that any desired rate of filtration, within certain limits, may be obtained.

A newer and more efficient method has been devised which is

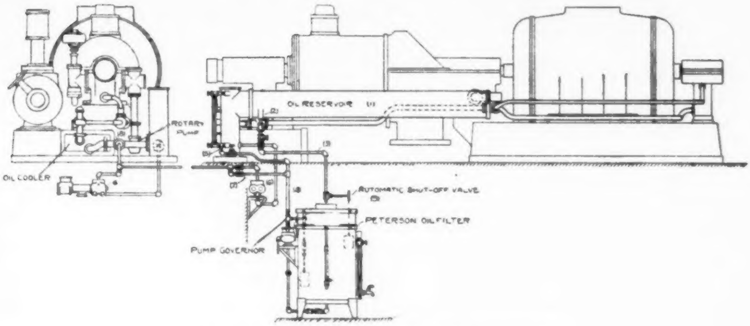


Fig. 1. Partial Filtration System

known as the partial system of filtration (see figure 1), by means of which anywhere from 10% to 50% of the amount of oil being circulated in the self-contained lubricating system is filtered and this latter system is in no way interfered with.

In the partial system some oil is continuously drawn off at the lowest and consequently the dirtiest point in the oil well of the turbine. By means of a suitable arrangement of valves and piping the desired proportion may be removed and conveyed into a filter by gravity. After the oil is filtered, a steam pump, automatically controlled by the head of oil in the clean oil compartment, pumps the oil back into the turbine system.

If we were to plot a curve with the percentage of foreign matter and "muck" in the oil, as a vertical, and the length of time the oil is used, as a horizontal co-ordinate, we would, in the case of a turbine using batch filtration, obtain a curve which would begin from zero, rise gradually to a maximum point on the vertical ordinate, then drop to zero when new oil was put into the turbine and gradually work up again so that the curve would look something like the teeth of a saw.

On a partial filtration system this curve would start from the zero point and rise vertically a very small amount and then stay absolutely parallel with the horizontal zero line, and *only a small distance above it.* In other words, the partial filtration system is so effective and the cost so comparatively small that it is by far the most desirable method of filtering turbine oil.

A type of filter well adapted to the partial filtration system is the Peterson filter as shown in figure 2. This filter employs the dry method of filtration and has a very large precipitation capacity, which is necessary to thoroughly remove entrained water.

The oil enters the filter through a removable strainer (2) and then passes by gravity to the heating compartment (3) and from there to the precipitation compartment, travelling very slowly over suitable baffle trays, where the water is removed and automatically ejected. The partly clarified oil flows into the filtering compartment (22). The filtering units are of the submerged type and so designed that filtration takes place by oil passing from the outside to the inside of the unit.

The cloth of this filter has no plaits or folds and the filtering unit

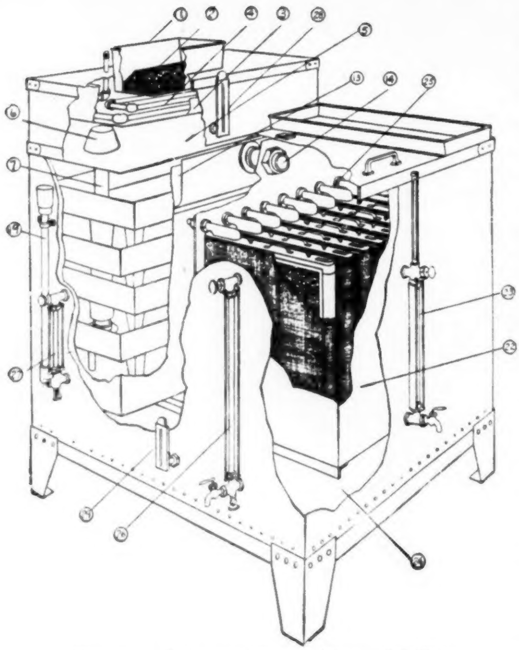


Fig. 2. Peterson Power Plant Oil Filter

is in a vertical position, thus allowing the accumulated dirt to gradually slide off. It is not, of course, entirely self-cleaning, but in order to remove a filtering unit for cleaning, it is simply necessary to withdraw the nozzle of the unit from the opening leading into the clean oil compartment. An automatic valve in this opening closes instantly and prevents the dirty oil from going to the clean oil side. Every square inch of filtering surface of this type of unit is effective. The quantity of oil filtered is directly proportional to the head above the filter units, and as considerable space is left over the units, the filter cloths can become quite foul before being changed and a great overload capacity is also possible.

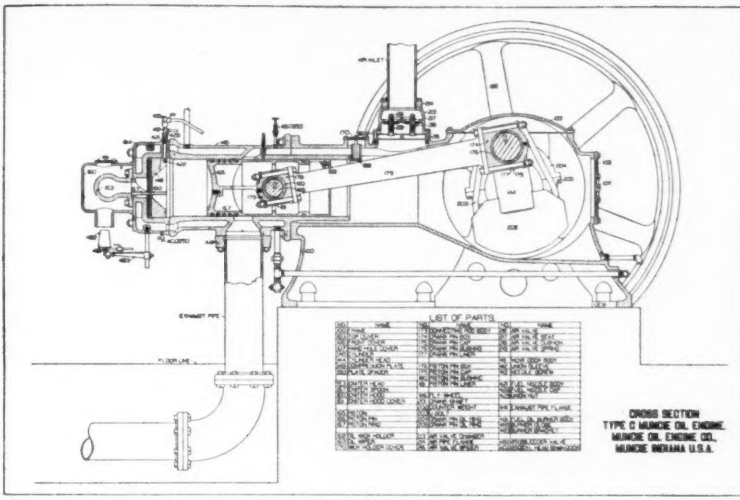
No matter how small or how large a steam turbine may be if the oil is not properly filtered, some time or other trouble is certain to occur. It is easy to forestall this by putting in an adequate purifying system.

THE MUNCIE OIL ENGINE—SEMI-DIESEL

By O. G. Deane

The accompanying illustration of a Muncie Oil Engine shows a type of Semi-Diesel engine that has been manufactured for twelve years by the Muncie Oil Engine Company of Muncie, Indiana. This engine operates on the familiar two-stroke cycle principle, the fuel being injected by a high pressure pump, which is controlled and actuated by a governor of heavy construction secured directly to the crank shaft. The governing is automatic, the stroke of the pump varying according to the load through all load changes, and the makers claim a regulation of better than two per cent under full load change.

This engine uses any liquid fuel commercially obtainable, and is warranted to operate, with the utmost satisfaction, on heavy residual oils between 24 and 30 degrees Baumé. It likewise uses crude oil and more fluid oils such as gas oil,



solar oil, naphtha, distillate, tops, or kerosene. In fact, the only restrictions are that oils shall not contain dirt, grit, or sediment, nor an excessive amount of sulphur, water, or asphaltum, and be thin enough to pump, at least when pre-heated by the water from cylinder jackets. A simple device for such purpose can be provided for heavy bodied fuels in the colder months.

Tests made upon these engines show a consumption of slightly less than .58 pounds (.078 gals.) of 26°—28° Baumé fuel oil, and less than .6 pounds (.088 gals.) of 40°—42° Baumé kerosene per B. H. P. per hour at full load. The economy at fractional load is also very good, being less than .80 pounds (.11 gals.) of fuel oil at half load and approximately 1.40 pounds (.19 gals.) at ¼ load. This particular test was upon a small engine, 9x13, operating 250 r. p. m. rated 20 B. H. P. The piston travel, 542 feet per minute, is lower than even many four-cycle engines, and much value is attributed to this feature in increasing the life of moving parts.

About two and one-half gallons of cooling water per H.P. hr. is circulated by an eccentric driven plunger pump. Jacket temperatures do not exceed 120 degrees Fahrenheit on any fuel. Lubrication is accomplished by two-compartment force feed lubricators, employing a good grade of oil engine cylinder oil for the cylinder and piston pin, and a good bearing oil on the crank pin and two shaft bearings. The piston pin is hollow and is oiled through a wick holder on front of the piston, communicating by a tube through the piston boss to the piston pin. The crank pin is oiled by a centrifugal oiler ring. It is shown that but a small amount (1½ gals. per 100 H. P. hrs.) of lubricant of proper grade is required for cylinder and slightly less for all bearing lubrication.

The sectional drawing shows an important improvement in the combustion chamber in this type of engine. The fuel being sprayed into the combustion chamber at the end of the compression stroke is confined to a small central zone,

and comes in contact with parts that are red hot, or nearly so, shown as Igniter Head, Igniter Spoon, and Compression Plate. This contact ignites the fuel vapor, and as some fuels are more easily fired than others a simple arrangement is provided to modify the compression to suit any fuel. The spacers back of the compression plate are each of different thickness; all spacers being removed will give the lowest compression ever required and the combination of one or more of the spacers with the main plate will permit an adjustment to suit the flash point of any other fuels which may be employed. This is a patented feature of this engine, which is quite necessary for meeting the variety of fuels that may be employed in different localities or plants. The engine will operate without these changes but not so economically, as it requires more compression for heavier fuels and *vice versa*. The size of the igniter head may also be changed to permit more heat being held or radiated as is required.

As the cylinder head is entirely water cooled, the flange of the igniter head is never excessively heated. Moreover, there is no danger of cylinder heads "blowing up," as the temperature throughout is reasonably uniform and the heat of combustion is not subjected directly to any point of the cylinder head, but to the igniter spoon, igniter head and compression plate.

The crank case compression is very low for this type of engine, less than half that employed in two-cycle gasoline engines. It is approximately 1½ pounds, yet sufficient volume at this pressure scavenges as thoroughly as practicable in any two-cycle engine, as the above efficiency indicates.

The specifications show the proportionate weight of the entire line of Muncie engines from 10 to 100 H. P. to be about 310 pounds per H. P., which is a decided advantage in any engine designed to use heavy oil, incident to which is high initial compression, or at least high pressures attained during working stroke. The type C unit is known as Special Heavy Duty Type, being made in sizes 40 to 100 H. P., all with three-piece (top and lower shell and cheek piece) liner and adjustable wedge type of bearings, the lower shell of which is water cooled by the regular water circulating system.

Muncie Oil Engines are in wide use in oil country service, especially in the Southwest, where low grade crudes are produced, and many are using 18° and 20° Baumé crude as it comes from the well. Mexican crudes of 14° Baumé have been employed successfully, but carrying a higher content of asphalt than it is deemed advisable for continuous use.

The oil situation at the time of writing is particularly favorable for this type of engine, as fuel oil of the desired specifications, 24°—28° Baumé, is quoted at a low figure, and as its abundance, insuring quick deliveries, relieves the pressure of a few months ago.

The fuel cost is remarkably low with this engine, and as it is believed by some that the attendance cost and ultimate service is sometimes more important, it may be remarked that a number of Muncie Engines have in actual service run from two to five months without a moment's shut down, or in a year's time would not total 24 hours in idleness. Its simplicity recommends it for any plant where attendance cost is a burden. The rigid construction of

all parts also insures low repair cost.

Muncie Oil Engines are of single cylinder, horizontal type and for stationary use only. The frame is cast with the crank case integral. The cylinders are securely bolted to the frame, and have a long sleeve of cylinder wall, as noted in the sectional drawing, projecting to the crank chamber for supporting the piston, which, in connection with a long trunk type of piston and connecting rod centers of six crank throws, relieves the objectionable element of wear and trouble experienced when short connecting rods exert high pressure from the oblique angle at which they work.

From five to seven concentric snap rings are used, all being returned on inside, and on periphery. The cylinders are reamed to within ½ of 1000th inch, insuring an absolute standard of fit with the piston and rings. Metals are carefully graded, the scleroscope test being used to obtain the degree of hardness and the proper difference between cylinder, piston, and rings, the latter of course being softer.

With all heavy oil engines, next to good combustion, proper lubrication has been the greatest trouble. Satisfaction can be obtained only by a careful selection of materials and making fits, and by co-operating with lubricating companies to secure or develop grades of oil that will give the desired lubrication. When this is done the wear will not exceed that of a natural gas or gasoline engine.

A remarkable feature of MUNCIE ENGINES is the regulation, which, even in the commercial type of engine, is within 2% under full load change, and with the Special Electric engine provided with heavier wheels, suitable regulation for the most exacting conditions, paralleling alternators, is absolutely guaranteed.

SUMMARY REPORT
TEST OF LUBRICATING OILS FOR SEMI-DIESEL ENGINES

The Muncie Oil Engine Co., Muncie, Indiana
June, 1916

In the test hereinafter recorded, it was desired to bring out the relative merits of the competitive oil being recommended and TEXACO URSA OIL, by way of comparing oil consumptions and also fuel consumptions, the latter being indicative of the efficiency, since the load was maintained constant. It was further desired to demonstrate that one oil could be used economically and efficiently for the lubrication of the entire engine, both for external and internal parts. The entire matter came under the direct supervision of Mr. O. J. May, Chief Lubrication Engineer, Chicago District, and Mr. C. M. Larson, Operating Lubrication Engineer, representing The Texas Company, together with Mr. O. G. Deane, Manager of the Muncie Oil Engine Company. Mr. Deane was represented by

Messrs. J. H. Fisher, Superintendent, T. R. Livingston, M. E., and Frank Hedstreand, Testing Foreman. All data gathered was very carefully checked, and the results tabulated below may be considered absolutely authentic.

The unit selected for the test was a 20 B. H. P. Semi-Diesel type, designed to burn all grades of heavy fuels. In the runs made, however, kerosene was the fuel used for the reason that considerably more difficulty is experienced with this lighter grade of product in the way of poor lubrication. The trouble presents itself in the marked tendency of the oil film to be washed from the cylinder surfaces, an effect which is not as noticeable with the use of the heavier grades of fuel. During the use of kerosene, water is injected into the cylinder; and this, in its natural state as well as when converted into steam, lends its aid in washing the lubricant from the cylinder surfaces. Thus it was hoped that by taking the most severe conditions it would be possible to bring out the comparisons from several different angles. As near as was humanly possible the mechanical conditions were kept the same during the runs on both oils. The engine was thoroughly cleaned throughout, including the piston and cylinder surfaces. The fuel consumptions were accurately weighed, and the oil used was measured in cubic centimeters. During the tests, bearing temperatures were also recorded, and at the completion of each run the condition of the reclaimed oil was noted and samples taken; observations were also made to ascertain the general condition of the cylinder walls, and the thickness of the oil film thereon. The latter figure was secured by allowing a properly formed weight of one pound to remain on a pad of Riz-la-Croix cigarette paper for five minutes, noting the penetration and figuring each sheet at .001″.

The arrangement was such that oil was fed through a two-compartment McCord lubricator, one side of which had two outlets, the other three. Of the two feeds, one was led to the top of the horizontal cylinder, the other to the wrist pin. Of the other three feeds, there was a line each to the two main bearings and to the crank pin. The oil from the main bearings may be separately drained, but that which works out the end of the cylinder becomes mixed with the oil draining from the crank pin to the crank pit.

The competitive oil used was recommended by the technical department of a large and well-known oil company. This oil has a relatively high per cent of animal compound, having been so recommended in order to meet the water condition within the cylinder.

The TEXACO URSA OIL submitted is a straight mineral pale filtered oil of high viscosity. In order that the tests might be made on an even basis, it was agreed to use the competitive oil on all external parts as well as in the power cylinder, during the test on that oil, following the same plan with URSA oil.

The general engine data and information gathered during the test runs are shown in tables below:

General Data

Engine

Manufacturer	Muncie Oil Engine Co.
Type	Semi-Diesel 3 BN
Number	236

Cylinders

No.	1
Bore	9″
Stroke	13″
Speed	250 r. p.m.
Compression	110 lbs. per sq. in.
Fuel	Kerosene

Oil Under Test

	Competitive Oil	Texaco Ursa Oil
B.H.P. Developed	20	20
Speed (r.p.m.)	250	250
Fuel consumed per H. P. hr.	.625 lbs.	.6 lbs.
Oil consumed per 1000 H.P. hrs.	6.25 gals.	4.4 gals.
Cost of oil (gals.)	\$0.32	\$0.40
Cost of oil per 1000 H.P. hrs.	\$2.00	\$1.76
Avg. frictional temps. of bearings	29°F.	23°F.
Thickness of oil film left on cylinder	.001	.003
Condition of cylinder and piston	Dry with rust spots	Clearand in bright condition

Reduction in fuel consumed per H.P. hr.	.025 lb. or 4%
Reduction in oil consumed per 1000 H. P. hrs.	1.85 gal. or 29.6%
Reduction in cost of oil per 1000 H. P. hrs.	\$0.24 or 12%
Reduction in bearing temperatures	6°F. or 20.6%
Increase in oil film	.002″ or 200%

It will be seen from this data sheet that very marked results are shown in favor of the TEXACO URSA OIL. That the efficiency of the engine was increased is indicated by two factors; the first being the reduction in fuel consumption and the second the reduced frictional bearing temperatures. Besides indicating more effective lubrication, the first point also brings out the presence of a better seal at the piston rings, a fact which was concretely demonstrated in the film test. This indicates that the fuel does not cut the URSA oil as readily as in the case of the competitive oil, and thus there is not the tendency to wash away or weaken the oil on the cylinder surfaces and it is left in a better condition for the performance of its functions. This point is further emphasized by the fact that a very appreciable saving in oil consumption was effected. That the TEXACO URSA OIL had remained in an unbroken seal during the entire operation is brought out by the condition of the cylinder after the run, which was found to be clear and bright. This is opposed to the rust formation and dry condition recorded for the competitive oil.

Another valuable point not shown in the data table is the resultant condition of the oil reclaimed from the crank pit. In the case of the competitive oil, this was withdrawn as a thick coagulated mass, showing the effects of emulsification and decomposition due to the contact with water and the heat of the cylinder. On the other hand, the TEXACO URSA OIL which was removed was not emulsified at all, and might be filtered for re-use. A large saving might be effected at this source, to be added to the economy previously noted. Furthermore, with the use of TEXACO URSA OIL it can be seen that the two-compartment lubricator may be replaced with one of single compartment and the oil from all parts may be drained into one pit, thus, in a measure, simplifying the design.

Results such as have been obtained during this test are very gratifying, for they bring out the points upon which the efficiency of the engine in service depends, and which are in so many cases the real sources of trouble to the operator. These figures, it is believed, are especially valuable,

for each item checks with the others.

The courtesies shown by all representatives of the Muncie Oil Engine plant are very sincerely appreciated, and we wish to express our thanks for all favors extended.

Respectfully submitted,
THE TEXAS COMPANY
(Signed) O. J. May.
Chief Lubrication Engineer,
Chicago District.

EDITOR'S NOTE:

Since the summary report has been written, we are in receipt of a communication from the Muncie Oil Engine Company, in which they state that in further tests, lubrication has been reduced to 3.6 gallons of TEXACO URSA per 1000 H. P. hours. Examination on the morning after the test showed that the cylinder was well lubricated, there being an abundant film of oil on the rings and piston, with no indication whatever of rust. With kerosene it had been a common objection, where just ordinary grades of gas engine oils were used, to find some difficulty in starting the engine after the night's shut down, due to carbon or to the dry condition of the cylinder.

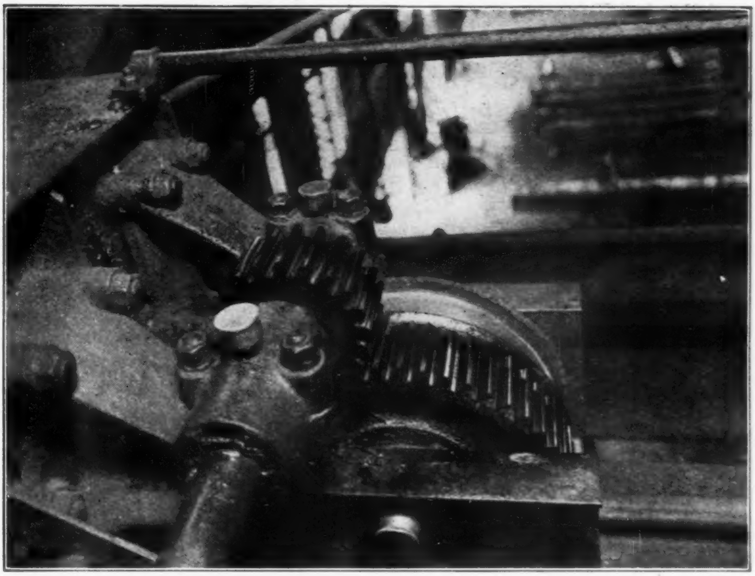
ELECTRIC CRANE LUBRICATION

From a Report by S. C. Eberhardt, Salesman

On July 19, 1916, the master mechanic and the shop foreman of the largest steel mill in my territory started a test with CRATER COMPOUND on a Shaw 5-ton Electric Crane. The pinion and gear on one side of the crane were to be lubricated with Crater Compound and the corresponding pinion and gear on the opposite side of the crane were to be lubricated with the competitive grease which they had been using. The pinion is 6″ in diameter by 2¼″ across. The teeth are ¾″ deep with 1″ circular pitch. There are about 25 teeth to the pinion which drives a 16″ 50-tooth gear attached direct to the driving wheel.

The pinion and gear were thoroughly cleaned and about ¼ pound or less of Crater Compound was applied hot with a brush. The crane was immediately driven at full speed about 100 feet to the end of the track and back. This operation was repeated five or six times and the gears were then inspected and found to be well covered, and the shop foreman told me to return in a week to see the result.

When the week was up the master mechanic and myself inspected the gears, and he was astonished with the results of the test. This crane had been working continuously every day during the week and every tooth on both the pinion and the gear was covered with a film of CRATER COMPOUND which presented the appearance of a light coat of light brown varnish or shellac. Upon applying his finger to one of the teeth a slight quantity of CRATER came off. This puzzled him, and turning to me he said, "I don't understand this. It rubs off on my finger, yet the pressure on the teeth coming together cannot crush it out." On the opposite side of



Gear Lubricated with Crater Compound

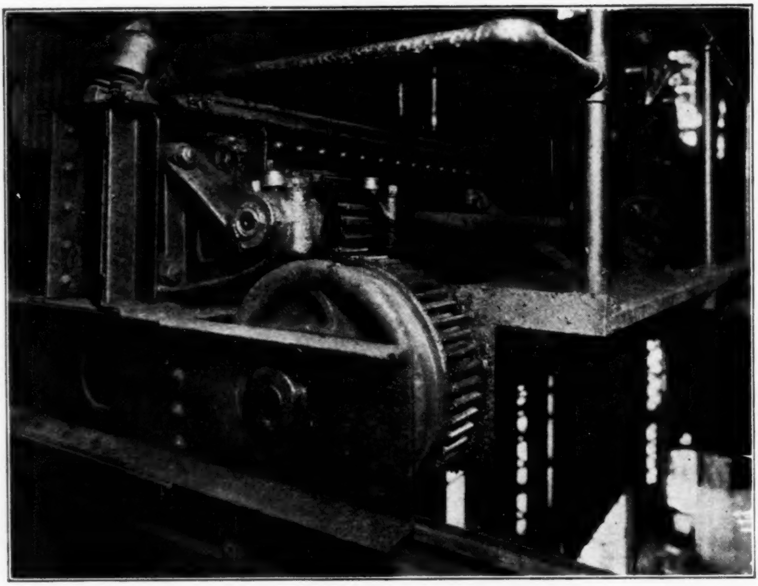
the crane the competitive grease had been applied every second day all the week and every tooth was bare. As a matter of fact, that grease was everywhere except on the wearing surfaces. The driving wheel was covered with it and the bottoms of the teeth were full and it was plastered all over, while the CRATER side was as clean as the proverbial hound's tooth.

The master mechanic immediately put in a requisition to the Purchasing Agent for a barrel of Crater Compound, and the order will come through in the regular way. When this barrel is received, I will call and instruct the men how to apply it.

The gears are highly polished cut gears, the pinion running 600 r. p. m. The crane goes ahead at great speed, stops with a jerk, reverses, and goes ahead again, so that the back as well as the front of the teeth receive the same hard wear. I think it will be difficult to find a more severe test for a gear lubricant. In this case it has been demonstrated conclusively that when properly applied CRATER COMPOUND is eminently suited for small high speed pinions and gears, as well as for heavy slow moving machinery.

Today, August 2nd, I called and secured photographs of the crane and of the two pinions and gears. The gear lubricated with Crater Compound was a source of great satisfaction to me, as this gear has now been working constantly for two weeks and one day with only one application of Crater Compound, and every tooth is still covered.

A touch of comedy was added by the boy who takes care of the crane. "Gee," he said, "that is great stuff. The other grease gets all over my clothes and my mother



Gear Lubricated with Competitive Grease

kicks when she washes them. This stuff don't throw off at all."

The theoretical increase in the lasting quality of Crater Compound over that of the competitive grease in this test was about 500 per cent, as CRATER COMPOUND lasted and was efficient at the end of two weeks constant use, whereas the other grease had been applied every other day. This does not mean that the competitive grease lasted two days because such is not the case. As a matter of fact, after the competitive grease had been put on and the crane sent on a couple of trips the teeth were entirely bare, and they were greased every other day only because of lack of time on the part of the crane tender. In view of these facts it would really be impossible to specify the percentage of superiority of CRATER COMPOUND over the competitive grease.

The operating force of this plant are very enthusiastic about CRATER COMPOUND. They have secured one of the special rope boxes for applying the compound to wire ropes and are going at the matter in an intelligent and thorough manner, figuring that a little trouble now will save a great deal of expense in equipment and labor later on. The conditions at this plant are rather severe because they are located on an island and their plant is directly on the water front, the salt water attacking the ropes and other equipment and coating all material in a short time with rust.